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Comprehensive flood mitigation and management in Velliangal Odai, Veeranam Tank, Cuddalore District, TamInadu State, India

N. Ravisankar[1] and S. Gnanakumar[1]

Department of Civil Engineering, Faculty of Engineering and Technology, Annamalai University, Annamalainagar 608 002, T.N., India

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ABSTRACT

Floods are naturally occurring processes that are difficult to prevent but can be managed in order to reduce its social and economic impacts. Mitigation is defined as a continued action to minimize risk property or human. The Muskingum model is a popular method to analyze the flood routing. The objectives of the study are to study the generating techniques for flood routing and also to evaluate the old used methods, to assess the accuracy of the available flow data and to check the results through basic flood routing methods and to find out the most vulnerable livelihood assess and also factors influencing to occupational and socio migration in the study area. The study area is Velliangal odai, Veeranam Tank, Cuddalore district, Tamilnadu state. The methodology used for this study is Muskingum method. The hydrometric data was applied in the study have been the collected from the public work department in Chidambaram (2001-2018), this data included water levels, inflow and outflow estimation. In this study, Reaches of different lengths were selected to assess the influence of river length in the application of flood routing methods. The Muskingum Parameters for the Velliangal Odai river at varying x calculated as shown in the graph is plotted with [K(Ix+(1"x) Q)] on x-axis and the storages on y-axis. The points indicate the formation of a loop and there is improvement when x tends to zero. In the beginning the loop was narrower at x= 0.35 but in the third trial at x= 0.25 is computed, found satisfactory. Therefore, the correct value of x can be taken as 0.25 for the Velliangal Odai River.

Key words : *Flood, Mitigation, Muskingum method, Hydrometric data, Flood routing*

Introduction

Flood is defined as an excess of water on land that is normally dry. Extreme rainfall level and excess of surface water flow is called flood. Floods are caused by many factors, heavy rainfall, and highly decelerated snowmelt, severe winds over the water, retention ponds, and other structural retained the water. During the rain, some of the water is retained in the ponds (or) soils, some water absorbed by the grass and vegetation and some water will be evaporating, remaining water travel our lands surface are called as surface runoff. Flood control is necessary all over the world. Flood control is anything that is used to help prevent (or) reduce the destruction of the flood water as advancing flood control is Minimize the flood damages and the violence of flood event, protect the life and property of living citizens within the food plains, protect public, help people have water to drink and provided water for industry and other irrigation purposes. Floods are natural occurring processes that are difficult to prevent but can be managed in order to reduce its social and economic impacts. Flooding is a threat to life and leads to damage of property. It is therefore very important that flooding risks be taken into account during any planning process. There are areas that are more susceptible to flooding than others. Poor infrastructure of the drainage system contributes to even more flooding risks. This therefore calls for proper planning especially for any proposals of development in areas that are prone to flooding. The flood control assessment required the information on the development of the area existing and proposed development information.

Mitigation is defined as a continued action to minimize risk property or human. Actually mitigation is the least concept, but it plays an important role in protecting communities for the disaster. Mitigation process is actually benefit for five minimizing influences of potential disaster, mitigation to direct damage to property, mitigation to direct damage in business activities, mitigation in natural environment for park and wildlife, mitigation in human casualties or homeless. Minimize the financial impact on community as mitigation reduces the disaster damage.

The Muskingum model is a popular method to analyze the flood routing. Most of the methodologies for estimating the parameters of the routing are based on the distance between observed outflows and estimated outflows. An exact method of solution of the flood-routing equation, when the storage is a linear function of weighted inflow and outflow, is developed. This operation is shown to be equivalent to routing a multiple of the inflow through reservoir storage and subtracting the excess inflow. Modified coefficients for the Muskingum equation are developed which do not depend on the routing interval being small relative to K.

Objectives of the Study

- To study the generating techniques for flood routing and also to evaluate the old used methods.
- To assess the accuracy of the available flow data and to check the results through basic flood routing methods.
- To find out the most vulnerable livelihood assess and also factors influencing to occupational and socio migration in the study area.

Study Area

Villages in the Velliangal Odai surplus namely, Vadakkuvadakkuklakudy, Sarvarajanpettai, Neivasal, Elleri, Thirunaraiyur, Killkilavannai which are located on the respective bank of Velliangal Odai is below the Anicut from the fury of flood it starts from the Lalpet and end of the Koppady near Kumaratchi. The actual length of the Velliangal Odai is 10.980 km from Lalpet weir to Koppady weir. The channel is called khan sahib canal an irrigation channel. The Koppady weir Ayacut is 2975 acres. The mean water level capacity from the three surplus weirs is 17903c/s. Maximum flood discharge through the surplus weir 3517c/site maximum flood of the Velliangal Odai is 21680c/s. Figure 1 shows the layout plan of the study area.

Methodology

Mushkingam Method

The graphical method procedure consists of generating graph of [XI(1-X)0] Vs. S. The optimal value of X is the produced the narrowest and straightest loop

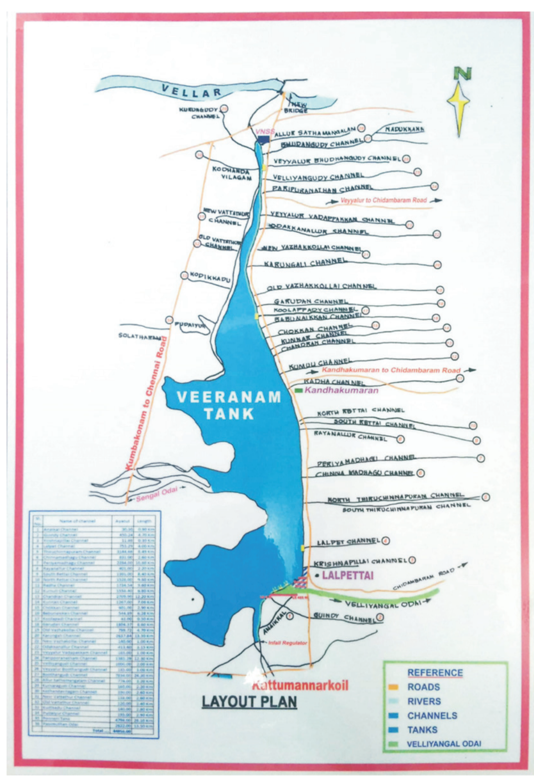

Fig. 1. Study area map

graph of [X1+ (1-x0] Vs. S. The available data for a series of flood events are inflow, outflow and a time increment of t for every one hour in calculation. The Muskingum method is a hydrological flow routing model. This method exacts solution of the flood routing equation when the storage is the linear function of a weighted inflow and outflow is developed modified co efficient for the Muskingum equations, are developed which do not depend on the routing interval is the small relative to K. describe the transformation of discharge (Q) waves in a river bed. Muskingum method is the relationship between the storage(S) and discharge (Q) and outflow is the not unique function in this method. In the use of method is however, the sometimes an essential requirement to the accuracy in such finite difference calculations. This method is based on the conservation of the mass which is applied to storage, inflow and outflow within the reach. Many le complicated methods have been developed for the flood routing problems. Most of the methodologies for estimating the routing parameter are based on the comparison between and the estimate outflow.

The basics of Muskingum method

The Muskingum method for flood routing was developed for the flood control study in the 1930 this is one of the most popular methods of hydrological routing method of drainage channel, river and streams. A negative wave is produced due to the outflow exceeding inflow of the channel. This method of the routing is the approximate the storage volume in a channel by a combination of the wedge and prism storage.

Prism storage

Is the volume that would exist if the uniform flow occurred at the downstream depth the volume formed by an imaginary plane parallel to the channel bottom draw at the outflow section of the water surface?

Wedge storage

The wedge like volume formed between the actual water Surface and the top of the prism storage. The wedge storage is =KX(1-Q). The prism storage is =KQ. K is the travel time through the reach and O is the flow through the prism. X is the weighting Factor in the range of the $0<x<0.5$. The X value is 0.5 in the natural streams x, is the more limited value in usually between the 0 and 0.3.

Calibration of the Muskingum parameter

The basic Muskingum method K and X can be graphically estimated from the available inflow and outflow data of the study area

Flood data analysis of the Muskingum method

Hydrological data

The hydrometric data was applied in the study have been the collected from the public work department in Chidambaram (2001-2018), this data included water levels, inflow and outflow estimation. This brief description of the equipment and the methodologies that have been used in the collecting and processing the hydrometric data presented in this study.

Water level recording

There are two equipment are used for the water level recording. They are 1. Autographic derrecor 2. Data loggers

Autograpic derrecor

Provides a reading noted weekly or monthly charts. This method depends on a gearing mechanism. The water level trace on the charts is then digitized to present a time series.

Data loggers

Is the more commonly used in the method of the recording using water level This device is used by the office of the public work department to digitally recorded the water level at a set of time interval. This used by the recorder refer to water depth recording the first stage gauge. This process is checking and validating of the data recorder.

Flow estimation

The river flow is not recorded continuously, but is estimated from the rating and recorded the water levels. The rating is a relationship that the equal to the given water level to the given flow at the particular section. The produced begins by the Muskingum the velocity at the series of the points across the river. This method is velocity area method. The methodology used calculates the flow (discharge Q) for a particular level stage is use a number of the gauging rang of the outflow.

Muskingum equation

This method of the Muskingum equation is the liner relationship are for the S in terms of I and QS=K (Xi+(1-x) Q this relationship is known as the Muskingum equation. In this parameter x is the weighting factor and takes the value 0 and 0.5 when x=0 the storage function of discharge only relation to the Muskingum parameter S=KQ. The storage is linear storage or linear reservoir. When X=0.5 both inflow and outflow are equally to the storage. The coefficient of the K is known as the storage time constant and the dimension of the time.

Calculating co efficient of Muskingum method

To find the co efficient of Muskingum method it is required finding the value of (X) and (K). Find these value, assume values for the values of (X and draw the values cumulative storage). The typical inflow and outflow hydrograph through the channel reach. Note that the outflow peak does not the point of the intersection of the outflow and inflow hydrograph using the continuity equation. (I1+I2) the interment in storage at any t and time element can be calculated. Summation of the various incremental storage values is unable to find out the channel storage vs. t Relationship. The natural channels the value of the x is lies between 0 to 0.5 for the reach of the value and K are the constant. The basics of Muskingum method K and X can be graphically estimated from the available inflow and outflow data of the reach of the interest, if S is the plotted against XI(1-X) Q, a straight line with a slope of K should result several value of the are treated. The value of the given loop in the plotted relationship is taken as the correct X value and slope of the plotted relationship is taken as the K values.

Muskingum method of routing

The Muskingum method is the single storage relationship. The given value of the channel reach by selecting a routing interval and using the Muskingum equation, the discharge in storage is S1-S2=K [x (I2-I1) + (1-x) (Q2-Q1) condition of the 1 and 2 refer the before and after time interval. They are the Muskingum equation is

S2-S1= {I2-I1/2}1+Q2) /2). The evaluated the equations are Q2=C0I2+C1I1+C2Q1.

Where

C1=Kx+0.5

C2=K-Kx-0.5 Note that the C0+C1+C2=1.0 this can be written as the general form of the nth equation.

Determination of Muskingum parameter

This study focused on the comparison of the result calculated from the hydrological models. In this study we have compared result of food routing inflow and outflow discharge using Muskingum method. Parameter of the Muskingum method are determining by using three methods. 1. Graphical method 2. Least square method 3. Regression analysis. The above three methods depend on data availability and for the time calculation. To use Muskingum equation to route a given inflow hydrograph through a channel reach K and X should be known. Knowing the value of K and X, select an appropriate value of t. Calculate C1, C2, and C3 values. Starting from the initial conditions known inflow, outflow calculates the outflow for the next time step. Repeat the calculations for the entire inflow hydrograph.

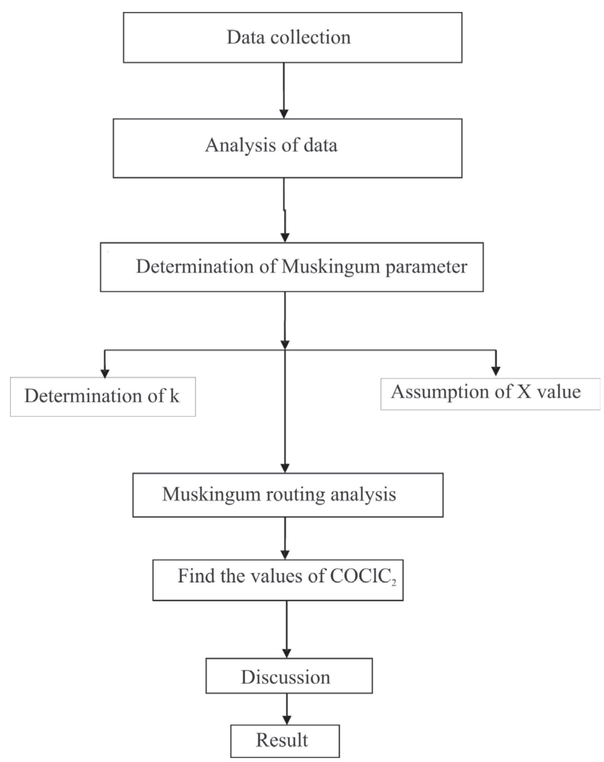

Fig. 2. Flow chart Methodology

Determined the graphically from the values of weighted flows vs. their pertinent storages. If observed inflow and outflow hydrograph are available for a channels value of K and X can be the deter-

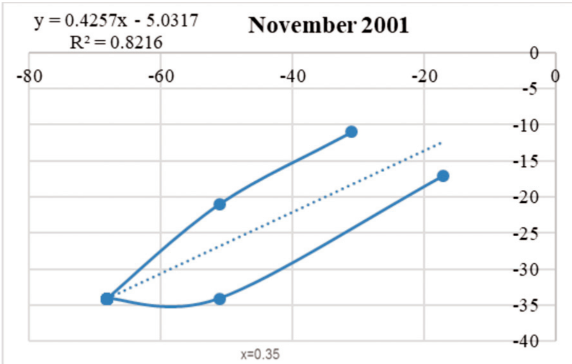

Fig. 3. River routing storage loop for X=0.35

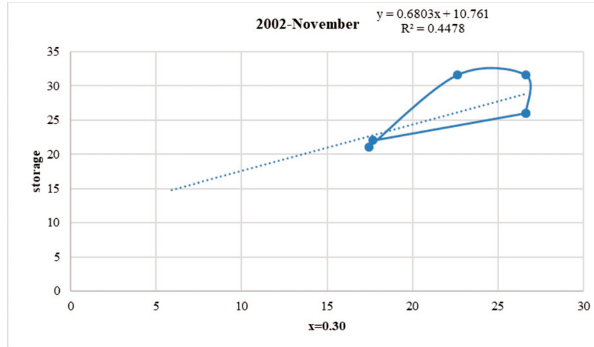

Fig. 7. River routing storage loop for X=0.30

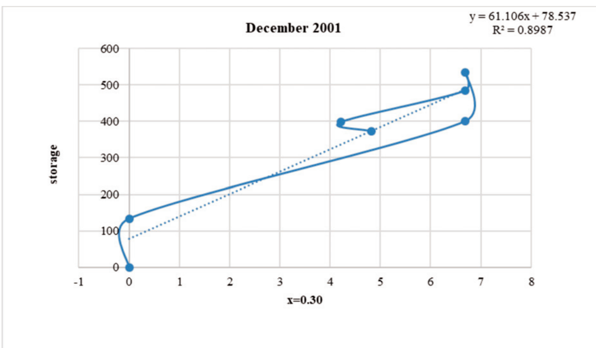

Fig. 4. River routing storage loop for X=0.30

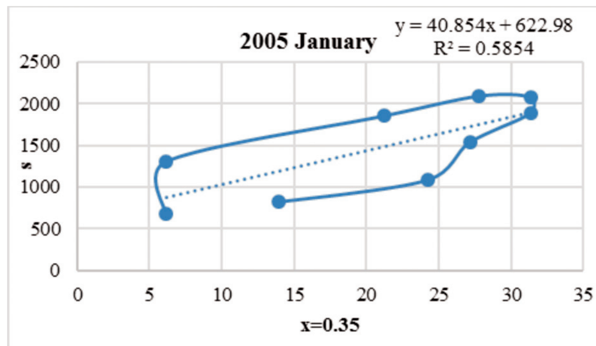

Fig. 8. River routing storage loop for X=0.35

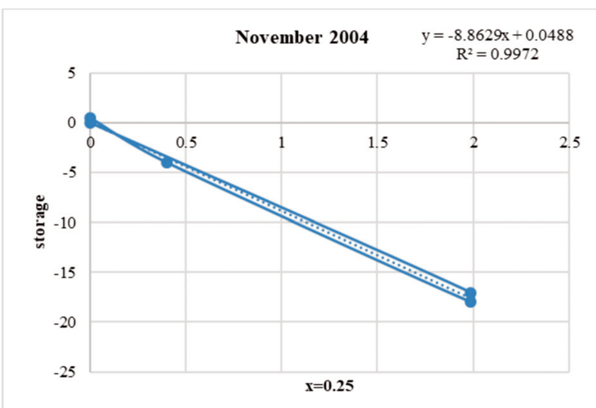

Fig. 5. River routing storage loop for X=0.25

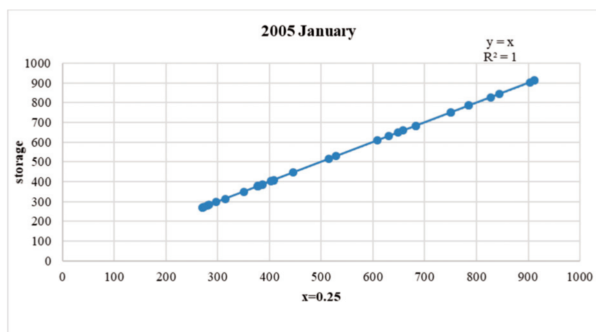

Fig. 9. River routing storage loop for X=0.25

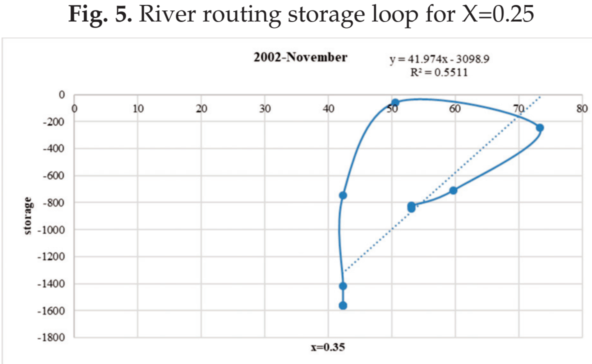

Fig. 6. River routing storage loop for X=0.35

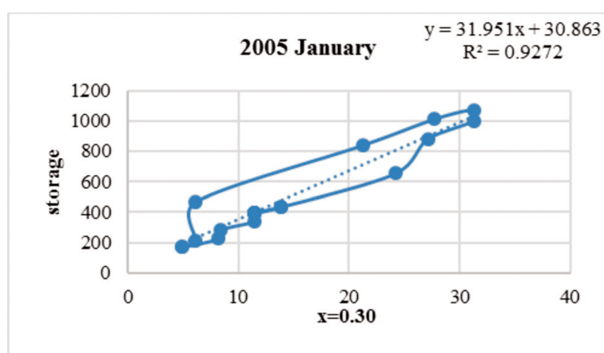

Fig. 10. River routing storage loop for X=0.30

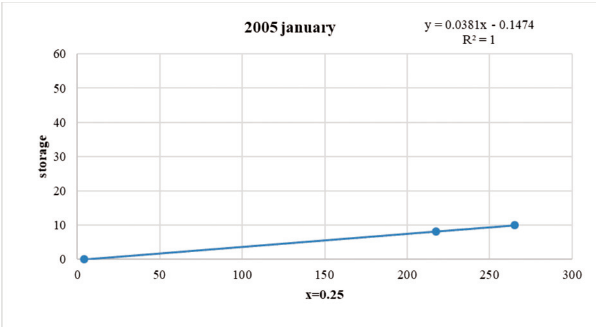

Fig. 11. River routing storage loop for X=0.25

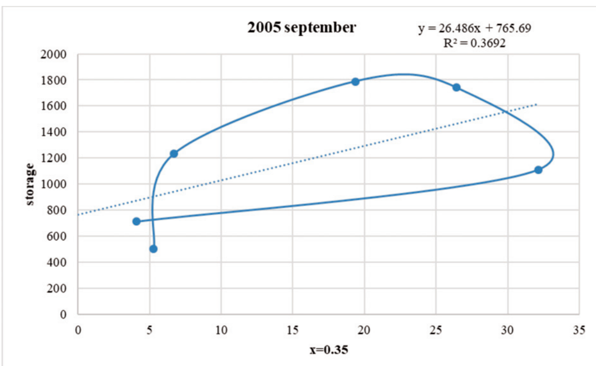

Fig. 12. River routing storage loop for X=0.35

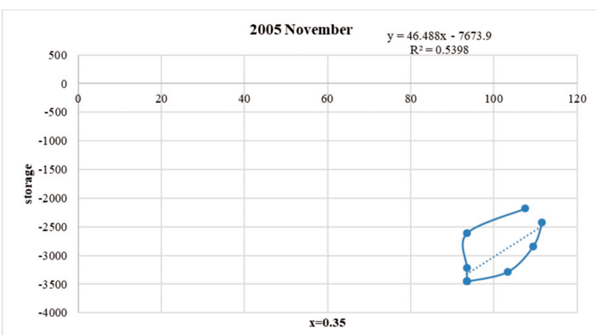

Fig. 13. River routing storage loop for X=0.35

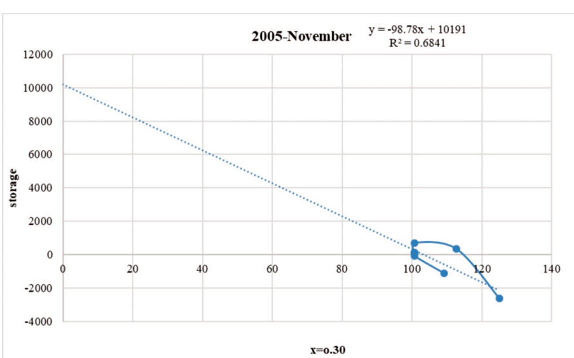

Fig. 14. River routing storage loop for X=0.30

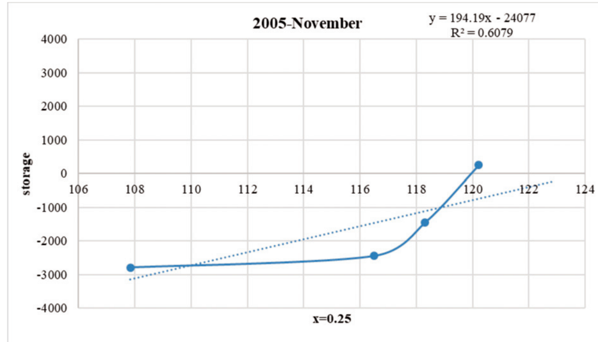

Fig. 15. River routing storage loop for X=0.25

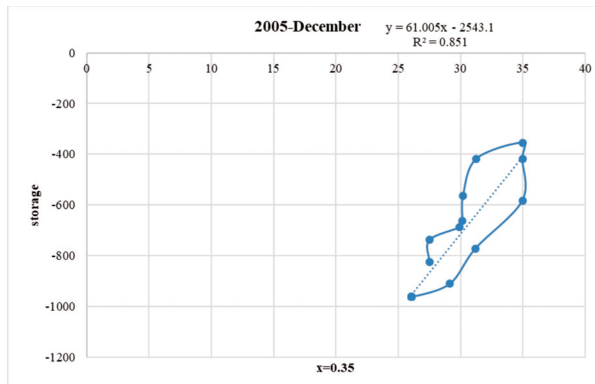

Fig. 16. River routing storage loop for X=0.35

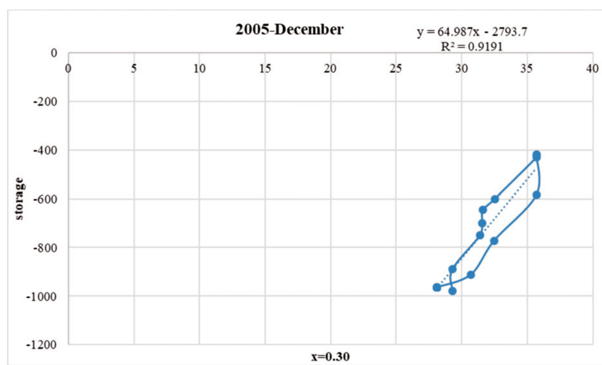

Fig. 17. River routing storage loop for X=0.30

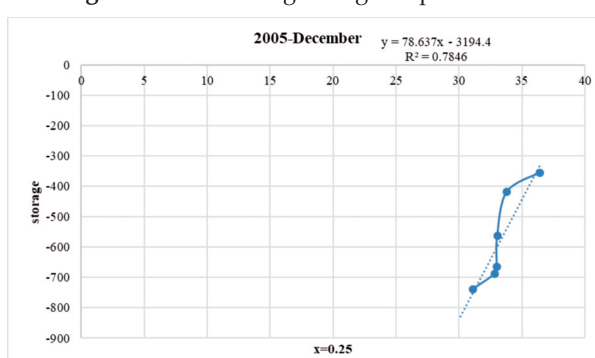

Fig. 18. River routing storage loop for X=0.25

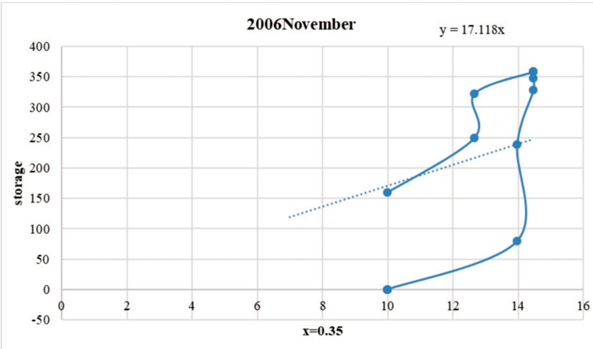

Fig. 19. River routing storage loop for X=0.35

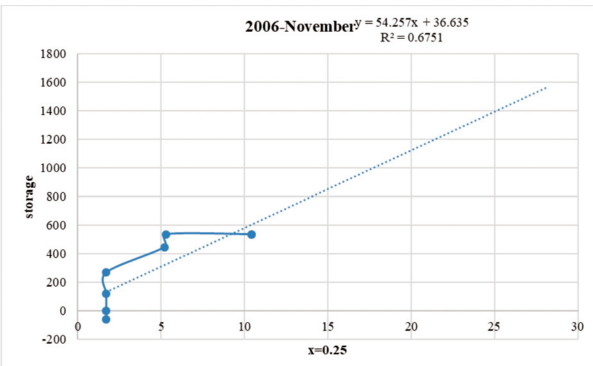

Fig. 20. River routing storage loop for X=0.25

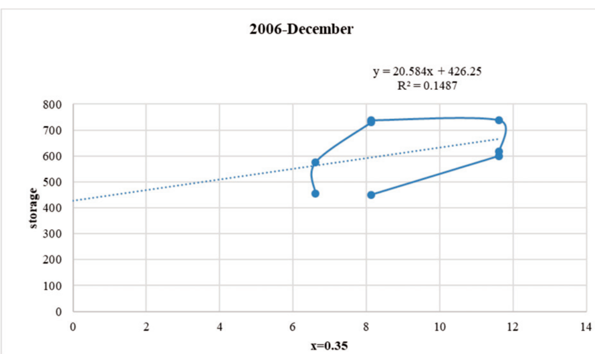

Fig. 21. River routing storage loop for X=0.35

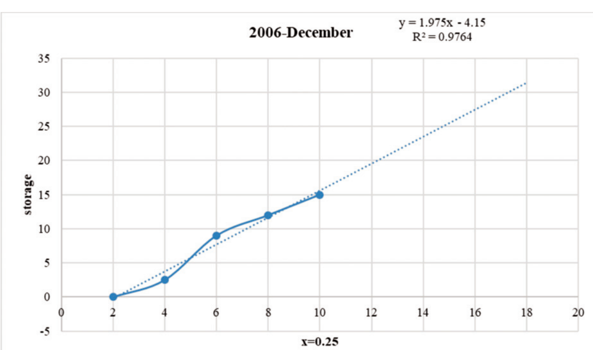

Fig. 22. River routing storage loop for X=0.25

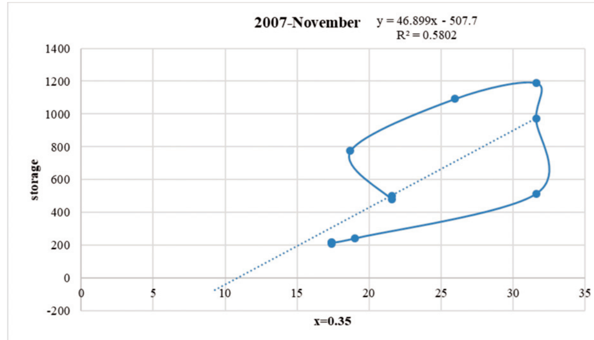

Fig. 23. River routing storage loop for X=0.35

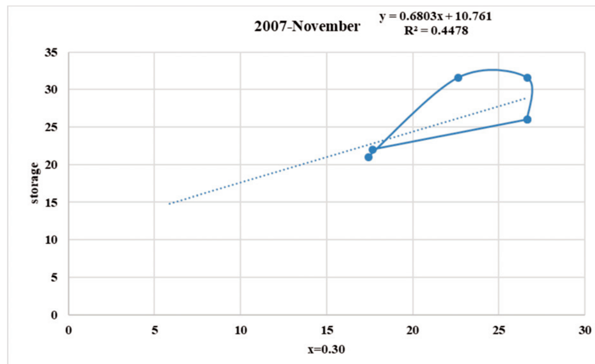

Fig. 24. River routing storage loop for X=0.30

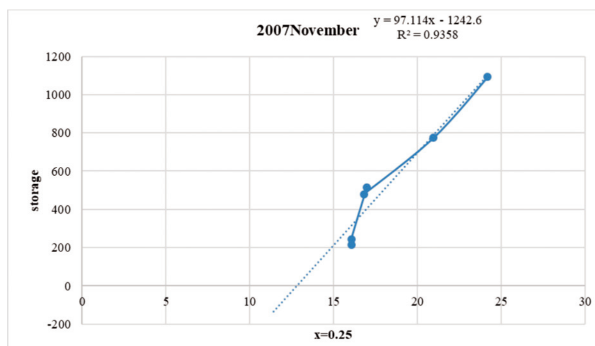

Fig. 25. River routing storage loop for X=0.25

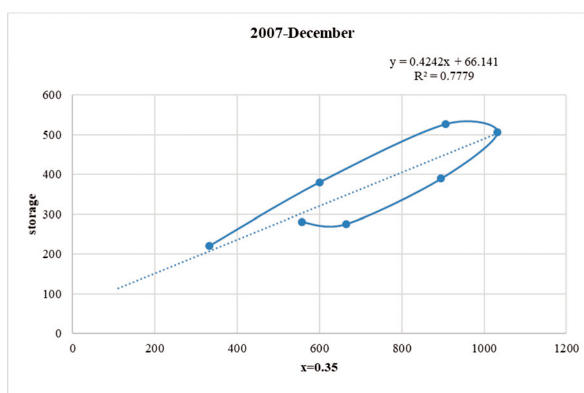

Fig. 26. River routing storage loop for X=0.35

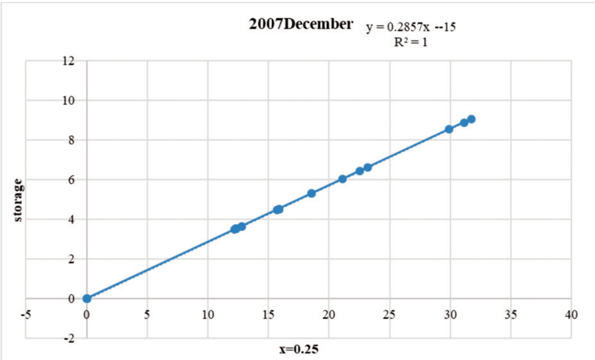

Fig. 27. River routing storage loop for X=0.25

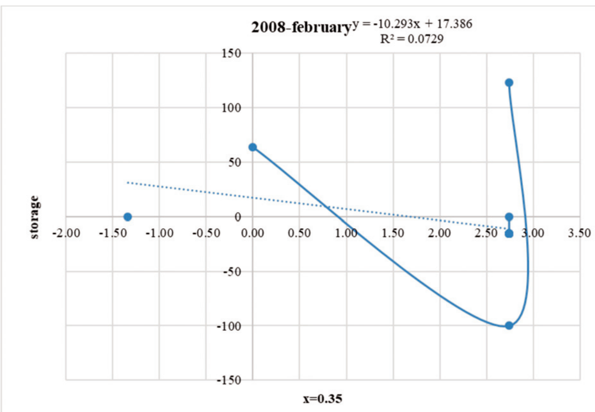

Fig. 28. River routing storage loop for X=0.35

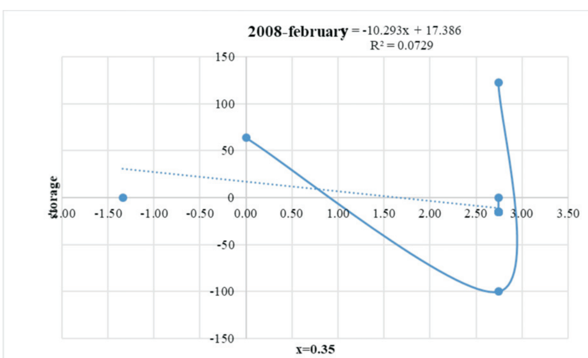

Fig. 29. River routing storage loop for X=0.35

mined. Assuming various values of x and using known values of the inflow and outflow.

Trial	X	K(h)	R^2
1	0.35	5.61	0.8216
2	0.30	5.69	0.8987
3	0.25	5.79	0.9972

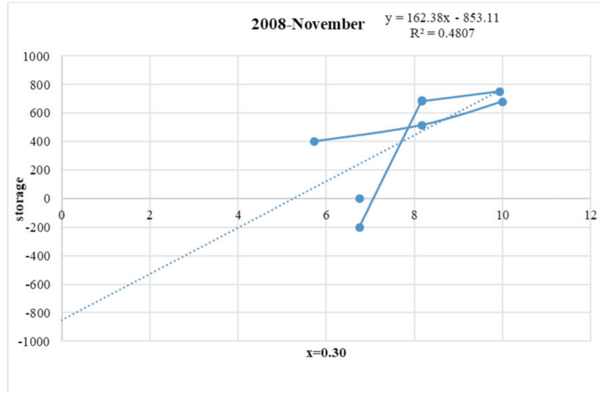

Fig. 30. River routing storage loop for X=0.30

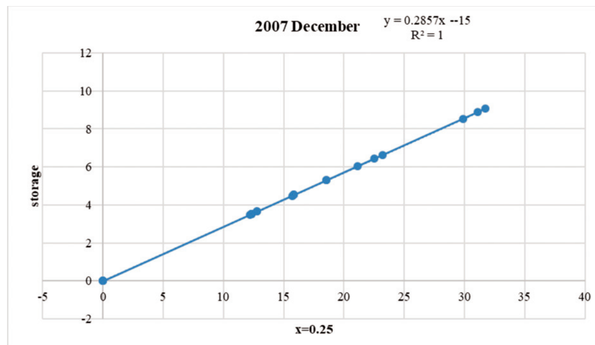

Fig. 31. River routing storage loop for X=0.25

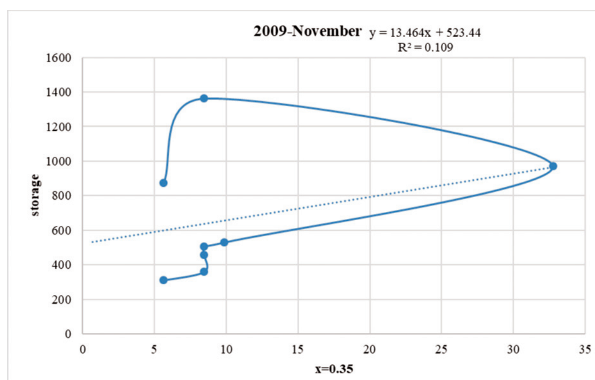

Fig. 32. River routing storage loop for X=0.25

Results and Disscussion

Calculation

S_2-S_1=$\left(\frac{I_2+I_1}{2}\right)\ \Delta t-\left(\frac{Q_2+Q_1}{2}\right)\ \Delta t$

From the equations is evaluated as

Q_2= $C_0I_2+C_1I_1+C_2I_2$, C_0= $\frac{-Kx+0.5\Delta t}{K-Kx+0.5\Delta t}$, C_1=

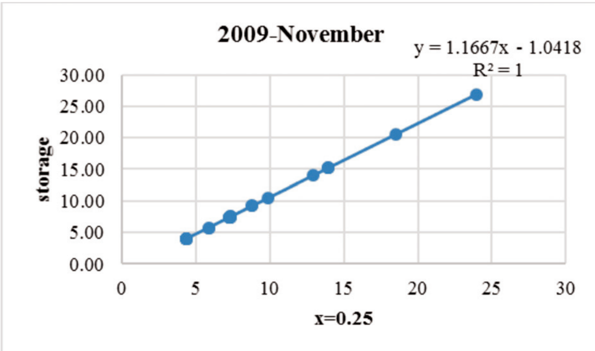

Fig. 33. River routing storage loop for X=0.25

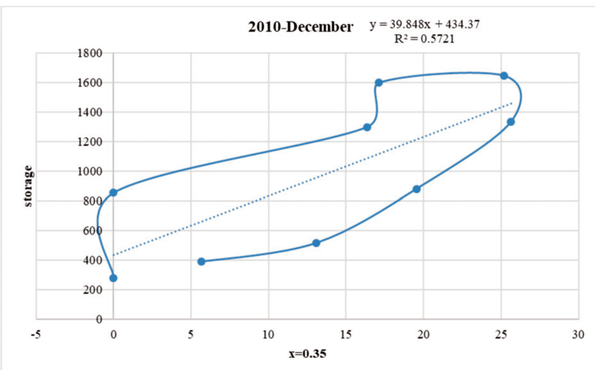

Fig. 34. River routing storage loop for X=0.35

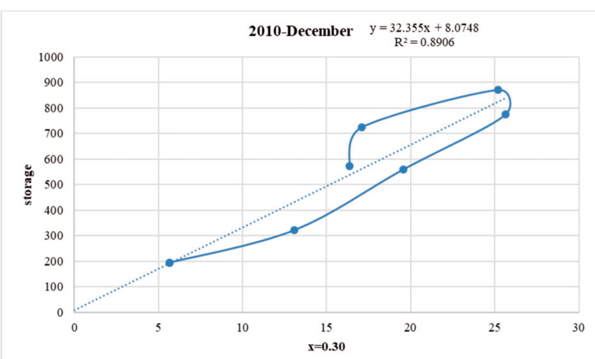

Fig. 35. River routing storage loop for X=0.30

$\frac{Kx+0.5\Delta t}{K-Kx+0.5\Delta t}$,

$C_{2=}$= $\frac{k-Kx+0.5\Delta t}{K-Kx+0.5\Delta t}$, Note that the equation is$C_0+C_1+C_2=1.0$ can be written as the general form of the n^{th} equations. C_o=$\frac{-Kx+0.5\Delta t}{K-Kx+0.5\Delta t}$ =

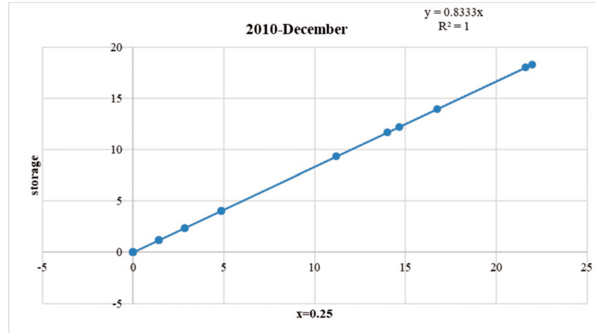

Fig. 36. River routing storage loop for X=0.25

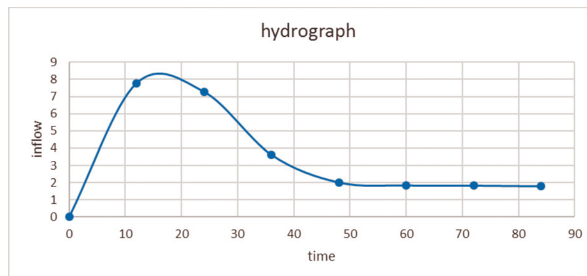

Fig. 37. Hydrograph of the study

$\frac{-12\times0.35+0.5\times6}{12-12\times0.35+0.5\times6}$ =-$\frac{1.2}{-13.2}$ =0.009

C_1= $\frac{Kx+0.5\Delta t}{K-Kx+0.5\Delta t}$ = $\frac{12\times0.35+0.5\times6}{12-12\times0.35+0.5\times6}$

$=\frac{7.2}{10.8}$ =0.66

C_2= $\frac{k-Kx+0.5\Delta t}{K-Kx+0.5\Delta t}$ = $\frac{12-12\times0.35-.5\times6}{12-12\times0.35+0.5\times6}$

=$\frac{4.8}{10.8}$ =0.44

Note that the equation is $C_0+C_1+C_{2=}1.10$. The values of k=12and 2kx = 2 ×12×0.25=6.0h in the case of Δt=6 which is satisfaction the condition is $C_0+C_1+C_{2=}1.10$

Time (t)	12	36	48	60	72	84	96	120
Inflow s(Q)	6	8	9	10	11	12	13	16

Note the first interval is 12 to 24 since the value of the I_1=65, I2=70, Q_1=65. From the equation is C_1I_1=4.29, C_0I_2=0.63 and C_2Q_1=2.86 from the complete equation is $Q_2=C_0I_2+C_1I_1$+ C2Q1=7.78m^3/s. For the next interval is 24 to 36 h, Q_1 is=7.78m^3/ s the second interval is 24 to 36 the I_1=6, I_2=7, Q_1=7.78 C_0I_2=0.063, =C_1I_1=3.96, C_2Q_1=3.32 Q_2= C_0I_2+C_1I_1+ C2Q1=7.28m^3/s. The interval is 36 to 48 h, Q1is=I_1=6, I_2=7, Q1=7.28 Q=C0I_2=0.063=C_1I_1=0.36, C_2Q_1=3.20=3.623

Next interval is48t0 60h I_1=6, I_2=7, Q_1=7.28C0I_2=0.063=C_1I_1=0.36C_2Q_1=1.59=2.013

Next interval is 60 to 72 I_1=6, I_2=7, Q_1=2.103, C0I_2=0.063=C_1I_1=0.36, C_2Q_1==1.89

Next interval is 72 to 84 I_1=6, I_2=7, Q_1=2.103, C0I_2=0.063, =C_1I_1=0.36, C_2Q_1=1.83

Next interval is 84 to 96 84 I_1=6, I_2=7, Q_1=2.103, C_2Q_1=1.80

Next interval is 96 to 120 C_2Q_1=1.79 m^3/s

The Muskingum Parameters for the Velliangal Odai river at varying x calculated as shown in the figures 3 to 36. The graph is plotted with [K (Ix+(1"x) Q)] on x-axis and the storages on y-axis. Hydrological flood routing techniques are widely accepted and are extensively used in engineering practice. The ability to predict the changing magnitude and celerity of a flood

Wave as it propagates along rivers or through reservoirs makes flood routing important in Designing hydraulic structure and in assessing the adequacy of measures for flood protection. However, in practice, only a limited number of gauging stations are available, and even Measured or gauged runoff data are frequently unreliable. To establish gauging stations is an Expensive task and on-going maintenance and service costs are also significant. As it is conducted in this study, the factors considered when selecting suitable gauging stations. For stream flow records include the availability and quality of data, and the suitability of the

River reaches to estimate flood routing parameters using Muskingum methods. In this study, Reaches of different lengths were selected to assess the influence of river length in the application of flood routing methods. From an inspection of the flow data, it was evident that Some of the observed hydrographs had unrealistic records, which might be due to technical Problems or to incorrect data acquisition. Hence, the quality of data was carefully examined Before selecting events for calibrating the Muskingum methods of flood routing from the analysis of both M-Cal and M-Ma methods, the results displayed reasonably similar Volume and shape compared to the observed hydrographs. Since, Reach-II and Reach-III are Long reaches, lateral inflows were added to the flood routing method. However, the addition Lateral inflow to the computed hydrographs in Reach-II and Reach-III was not sufficient to Obtain the observed peaks, but did results in outflow peak discharges, which were larger than The inflow peak discharges, as evident in the observed data. Since, the addition of lateral Inflow as used in this study considers only flows that are derived from the same rainfall event That resulted in the hydrographs, the under simulation of lateral inflow may be attributed to Inflow from other catchments caused by different rainfall events.

Conclusion

The points indicate the formation of a loop and there is improvement when x tends to zero. In the beginning the loop was narrower at x= 0.35 but in the third trial at x= 0.25 is computed, found satisfactory. Therefore, the correct value of x can be taken as 0.25 for the Velliangal

Odai River. The slope of the line in figure 3 at x=0.25 is found 0.9972 cusec-days which is equal to 5.79 hour. This value of slope K tallies the peak to peak time of the inflow and outflow Hydrographs as shown in figure. The R square values also calculated for each trail is shown in table to know the accuracy and in third trail at x=0.25 was found 0.9972, which is representing the best result. Therefore, for the Velliangal Odai value of x=0.25 and K=5.79 hour can be adopted. This implies that a flood wave Velliangal Odai would take about 6 hours to reach. This result will be useful for engineers for making remedial action at the downstream points, as and when necessary.

Refrences

Analysis of Flood Routing in Channels, 2018. *Journal of Rajarsh Rananjay Sinh Institute of Management & Technology,* Amethi, India, volume 6

Davis, 2009. Assessment of Channel Routing. *Journal of B.S.* University of California

Analysis of Muskingum Equation Based Flood Routing Schemes.

Assessment of flood mitigation strategies for reducing peak discharges in the Upper Cedar River watershed, (2014).

Calculating the Coefficients of Muskingum method, 2014. Journal of Babylon University Calibration and validation of Muskingum constants for river Godavari.

Calculating the Parameters of Muskingum Methods for a Rectangular Channel. *Journal of Y.T. College of Engi-*

neering & Management, University of Mumbai

Extended Muskingum method for flood routing, *Journal of Hydro Environmental Engineering,* Hydrabad.

Flood routing in engaged catchments using Muskingum routing method, 2005. Application of Flood Routing Model for Flood Mitigation in Orashi River, South-East Nigeria.

Flood Routing in Natural Channels Using Muskingum Methods. *Journal of Flood Routing in Natural Channels Using Muskingum Methods.*

Flood Routing in Natural Channels Using Muskingum Method, Dublin Institute of Technology.

Flood routing in engaged catchments using Muskingum methods. *Journal of Bio Resources Engineering and Environmental Hydrology.*

Flood routing by Muskingum method, Journal of Department of civil engineering, University of Ottawa.

Muskingum Flood routing method for the Titwala-C Nasik reach of Kalu River, Y.T. College of Engineering & Management, University of Mumbai

Parameter estimation of linear and nonlinear Muskingum models for River flood routing, Department of Hydraulics, Soil Science and Agricultural Engineering.

River Flood Routing by Nonlinear Muskingum Method, 1985. *Journal of Hydraulic Engineering University of Wyoming.*

Text Book of Engineering Hydrology by Subramaniya, third edition